

## Trends in Pertussis Activity, Utah, 1995-2005

### Introduction

This report summarizes pertussis trends as reflected in cases reported to the Utah Department of Health during 1995-2005. Pertussis is a highly contagious bacterial disease caused by the bacterium *Bordetella pertussis*. This vaccine-preventable disease is typically manifested in bursts of numerous rapid coughs (paroxysms), a whooping sound upon inspiration, and vomiting following the cough. The paroxysms can last for approximately six weeks, and recovery can take weeks to months. Older persons and those protected by the vaccine may become infected with *B. pertussis*, but often exhibit milder symptoms. Pertussis infections in adolescents and adults may present as a mild persistent cough and the inspiratory whoop is uncommon. Though the disease may be milder in older persons, infected individuals may transmit the disease to other susceptible and vulnerable populations, including unimmunized and underimmunized infants.

In Utah, pertussis activity peaked during the 1920s with an annual average of over 3900 cases for that decade (Figure 1). In 1926 alone, 8059 cases were reported. The introduction of the infant/childhood vaccine during the 1940s resulted in a dramatic decrease of cases, leading to a 90% reduction in total case counts by the 1950s. During the 1970s, the annual case counts averaged only 5 cases with a historic low of 0 cases reported in 1975. During the 1980s, however, reported cases began to increase in Utah. A major outbreak occurred in 1998 involving approximately 300 reported cases. Reported cases for 2005 numbered 620, a total count not viewed since the 1950s.

The increase in reported cases that has occurred in the last decade has primarily been viewed in the adolescent and adult aged population (Figure 2). These individuals are believed to become susceptible to pertussis approximately 6-10 years after childhood vaccination. It is also believed that improved recognition, diagnosis, and reporting of pertussis cases in these older age groups contributed to the increase in reported cases. Booster vaccines for these older age groups have recently been introduced, although it is too early at present to ascertain the effect on reported cases. Although the disease is typically mild in older persons, pertussis continues to cause significant morbidity in the infant population leading to hospitalizations and serious complications such as seizures and encephalitis.

### Methods

Pertussis is considered an urgent notifiable disease in Utah and requires immediate reporting to public health entities. A clinical (probable) case is defined as an acute cough illness lasting  $\geq 14$  days in a person with at least one symptom characteristic of pertussis (i.e., paroxysmal cough, post-tussive vomiting, or inspiratory whoop) or  $\geq 14$  days of cough in an outbreak setting. A confirmed case is defined as 1) a cough illness of any duration with isolation by culture of *Bordetella pertussis* or 2) a case that is consistent with the clinical case definition and is confirmed by polymerase chain reaction (PCR) testing or epidemiologic linkage to a laboratory-confirmed case. Data were accessed using the UDOH NETSS system. Only confirmed and probable cases were included in the analysis. Data were analyzed using SAS (version 9.1).

## Results and Discussion

During 1995-2005, a total of 1,741 confirmed or probable cases of pertussis were reported to the UDOH from 23 counties and 11 health districts. 55% of these cases were reported as confirmed. A 16-fold increase in reported case total occurred between 1995 and 2005. Cases were most frequently diagnosed during July, August, and September (Figure 3). The vast majority of cases were reported from the more heavily populated areas of Utah such as Davis, Salt Lake, and Utah counties. The 1998 outbreak occurred primarily in the Southwestern Utah Public Health District area (Washington County).

Among all pertussis cases with known sex, 873 (51%) were identified as female. Overall in Utah in the 1995-2005 time period, the average annual incidence was 6.3 cases per 100,000 persons per year (range: 1.3 in 1997, 20.3 in 2005) (Figure 4). Among 1,728 (99%) persons with known age, 345 (20%) were aged <1 year (including 286 aged <6 months), 274 (16%) were aged 1-4 years, 170 (10%) were aged 5-9 years, 372 (22%) were aged 10-19 years, and 567 (33%) were aged ≥20 years. By age group, average annual incidence was highest (61.7 per 100,000 persons per year) among infants aged <1 year. Incidence was lower for older groups: 14.3 per 100,000 persons per year for children aged 1-4 years, 7.5 for children aged 5-9 years, 7.5 for persons aged 10-19 years, and 1.8 for adults aged ≥20 years. The largest increases in incidence rates were observed in the 10-19 year old age group: 0.5 per 100,000 persons per year in 1995, 1.0 in 2000, and 37.0 in 2005. In accordance with the increasing incidence of reported cases in the older age groups, both the mean and median of reported cases have increased during the past 10 years (Figure 5).

Race and Hispanic ethnicity were considered independently. Data on race were available for 1,404 (81%) persons. Of these, 1,354 (96%) were white, 8 (0.57%) were black, 20 (1.42%) were American Indian/Alaska Native (AI/AN), and 22 (1.57%) were Asian/Pacific Islander (A/PI). Additionally for certain minority races (A/PI, black), the majority of cases were identified in the < 1 year age group (64% A/PI, 50% black). Age and race-specific incidence rates were higher for A/PI and AI/AN for ages 0-9 years compared to whites. Data on Hispanic ethnicity were available for 1349 (77%) persons with pertussis. Of these, 109 (8%) were Hispanic. Compared to non-Hispanics, a greater percentage of Hispanics were identified in the younger age groups (0-5 years).

Of the 1522 persons with known hospitalization status, 220 (14.5%) were hospitalized. 178 (80.9%) of these hospitalizations occurred in the < 1 year age group. Although rates of pertussis cases have dramatically increased in Utah during the past 10 years, rates of hospitalization have remained fairly steady, increasing only slightly during the past 3 years (2003: 0.8 per 100,000 2004: 1.1, 2005: 1.4) (Figure 4). No hospitalizations in the ≥ 20 year age category were reported until 2003 (Figure 6). Since 1999, the percentage of total cases reported identified as hospitalized has decreased, suggesting that the dramatic increases in total case counts are not reflective of increasing disease severity (Figure 7).

Radiographically confirmed pneumonia was the most frequently reported complication of pertussis with 85 cases being identified (4.9%); 16 (1.1%) cases reported seizures and 3 (0.2%) encephalitis (Table 1). Hospitalization and complications of pertussis were most common

among infants aged <1 year. Of all infants aged <1 year 178 of 297 (60%) for whom information was provided were hospitalized, 35 of 174 (20%) had radiographically confirmed pneumonia, 7 of 265 (3%) had seizures, and 1 of 256 (0.4%) had encephalitis. No pertussis-related deaths were reported in Utah during the 1995-2005 time period. In addition to a higher prevalence of serious complications, younger age groups were also more likely to have a more severe clinical presentation of pertussis (Table 2). Higher percentages of those aged < 1 year displayed vomiting and the characteristic “whoop” cough compared to older ages.

Among the 836 persons with confirmed status and known laboratory method, 416 cases (50%) were identified by PCR, 156 (19%) had an epidemiologic link to a confirmed case, 198 (24%) were tested by culture, 33 (4%) were tested by DFA, and 25 were tested (3%) by serology. Eight cases (1%) were identified via clinical diagnosis only. PCR use rapidly increased between 2003 and 2005, replacing culture as the most frequently used laboratory method. Differences in laboratory methods were observed between age groups (Figure 8). Infants < 1 year were more likely to be identified using culture or DFA and less likely to be epidemiologically linked as compared to older age groups.

Excluding those cases aged < 6 months, who are not eligible to receive the vaccine, of the 965 cases with known vaccination status, 652 (68%) were identified as having been vaccinated. Due to missing data, however, it remains unknown how many of these 652 cases received full vaccination (5 doses). For eligible individuals citing specific reasons for having not received vaccination, philosophical exemption (32%), parental refusal (38%), and religious exemption (17%) were the most frequently cited reasons.

## **Results and Discussion: Supplemental Hospitalization Information**

During 1995-2005, a total of 220 hospitalized cases of pertussis were reported to the UDOH from 18 counties and 11 health districts. 77% of these cases were reported as confirmed. The number of reported hospitalized cases has roughly increased 2-fold since 1995, compared to a 16-fold increase in all reported pertussis cases. Cases were most frequently diagnosed from June through September, although the trend in summer dates is not as distinct as in the non-hospitalized population. In 1995 and 1996, 50% of all reported pertussis cases were identified as hospitalized. No hospitalized cases were reported in 1997, although hospitalization status remains unknown for 90% of all reported cases that year. Despite the high total case count associated with the outbreak occurring in 1998, only 10% of identified cases were hospitalized. Since 1999, the percentage of total cases reported identified as hospitalized has decreased (1999: 39%, 2002:18%, 2005:7%), suggesting again that the dramatic increase in total case counts is not reflective of increasing disease severity.

Overall in Utah during the 1995-2005 time period, the average annual incidence was 0.85 cases per 100,000 persons per year (range: 0 in 1997, 1.4 in 2005). Among all hospitalized pertussis cases with known sex, 106 (48%) were identified as female. Among 220 (100%) hospitalized persons with known age, 178 (80.9%) were aged <1 year (including 166 aged <6 months), 15 (6.8%) were aged 1-4 years, 3 (1.4%) were aged 5-9 years, 8 (3.6%) were aged 10-19 years, and 16 (7.3%) were aged ≥20 years. Average annual incidence was highest (33.6 per 100,000 persons per year) among infants aged <1 year. Incidence was lower for older groups: 0.39 per 100,000

persons per year for children aged 1-4 years, 0.14 for children aged 5-9 years, 0.18 for persons aged 10-19 years, and 0.07 for adults aged  $\geq 20$  years. The largest increases in incidence rates were observed in the  $\geq 20$ -year age group: 0 in 1995, 0 in 2000, and 0.42 in 2005.

Race and Hispanic ethnicity were considered independently. Greater proportions of both racial and ethnic minorities were identified in the hospitalized population as compared to the non-hospitalized population. Data on race were available for 182 (83%) hospitalized persons with pertussis. Of these, 164 (90%) were white, 3 (1.7%) were black, 7 (3.9%) were American Indian/Alaska Native (AI/AN), and 8 (4.4%) were Asian/Pacific Islander (A/PI). Additionally for certain minority races (A/PI, black), a higher percentage of cases were identified in the  $< 1$  year age group as compared to whites (100% A/PI, 100% black) (Figure 9) Data on Hispanic ethnicity were available for 170 (77%) hospitalized persons. Of these, 27 (16%) were Hispanic. Compared to non-Hispanics, a greater percentage of Hispanics were identified in the younger age groups (0-5 years) (Figure 10).

Radiographically confirmed pneumonia was the most frequently reported clinical complication associated with hospitalization with 38 cases being identified (17%); 9 (4%) reported seizures and 1 (0.5%) reported encephalitis. Complications due to pertussis were most commonly reported in infants aged  $< 1$  year. Of the total infants aged  $< 1$  year, 27 (21%) of 127 had radiographically confirmed pneumonia, 6 (4%) of 155 had seizures, and 1 (0.7%) of 155 had encephalitis. No pertussis-related deaths were reported in Utah during the 1995-2005 time period.

Among the 184 hospitalized persons with confirmed status and known diagnostic laboratory method, 80 cases (44%) were confirmed by culture, 1 (0.5%) had an epidemiologic link to a confirmed case, 58 (32%) were confirmed by PCR, 27 (15%) by DFA, and 13 (7%) by serology. 5 cases (3%) were identified via clinical diagnosis only. Differences in laboratory methods were observed between age groups as well. Infants  $< 1$  year were more likely to be identified using culture or DFA and less likely to be epidemiologically linked to a confirmed case as compared to older age groups.

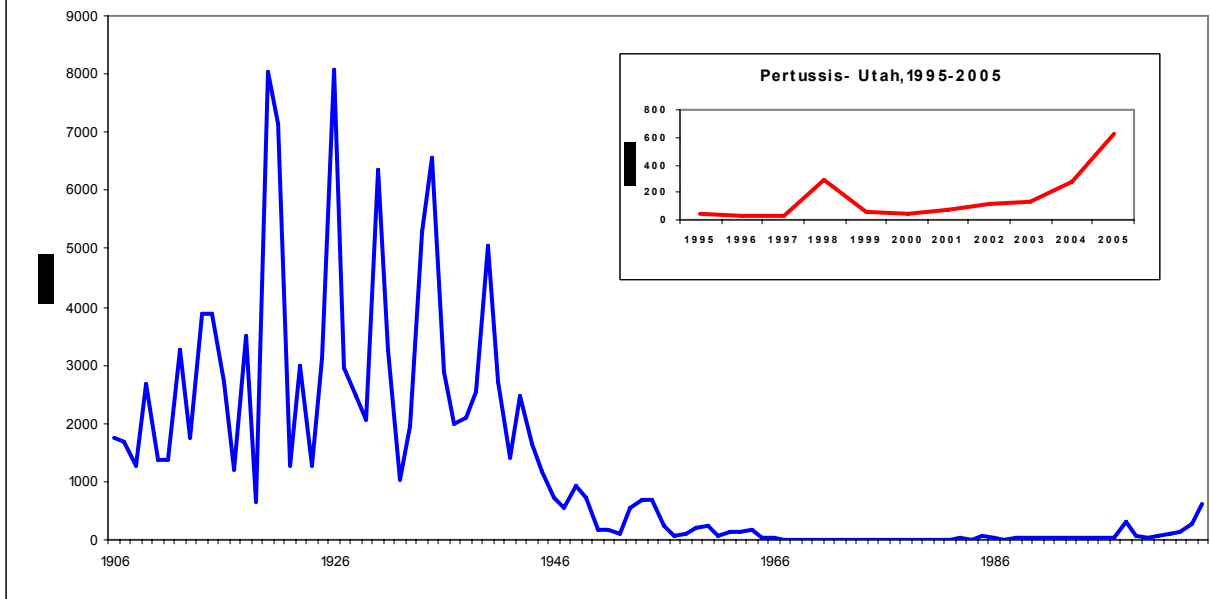
Excluding those cases aged  $< 6$  months who would not have been eligible to receive vaccine, of the 180 hospitalized cases with known vaccination status, 75 (42%) were identified as having received the vaccine. Due to missing data, however, it remains unknown how many of these 75 cases were fully vaccinated (5 doses).

## **Conclusions**

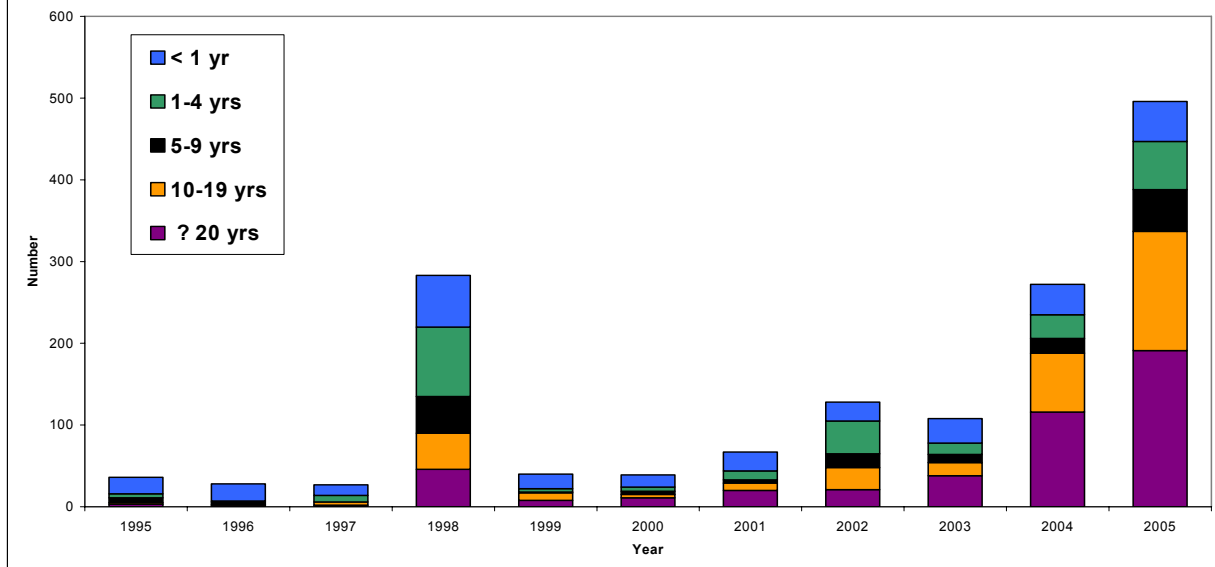
During the past ten years, major changes have occurred in reported pertussis cases. Total case counts have rapidly escalated with cases now occurring in adolescent and adult aged persons. Examination of hospitalization data, however, suggests that the increase in total cases is most likely not linked to increasing disease severity. As total case counts have increased due to adults and adolescents being identified, the total percentage of cases hospitalized has steadily decreased. However, infants continue to be disproportionately affected by severe complications and subsequent hospitalizations. Further disparities may exist in hospitalized cases related to race and ethnicity. New vaccines targeting older age groups are expected to reduce pertussis

cases both among adolescents and adults, and subsequently reduce inadvertent transmission to infants. Further analysis will be needed to determine if the new vaccine does lead to a reduction in cases and to better describe possible disparities in disease morbidity.

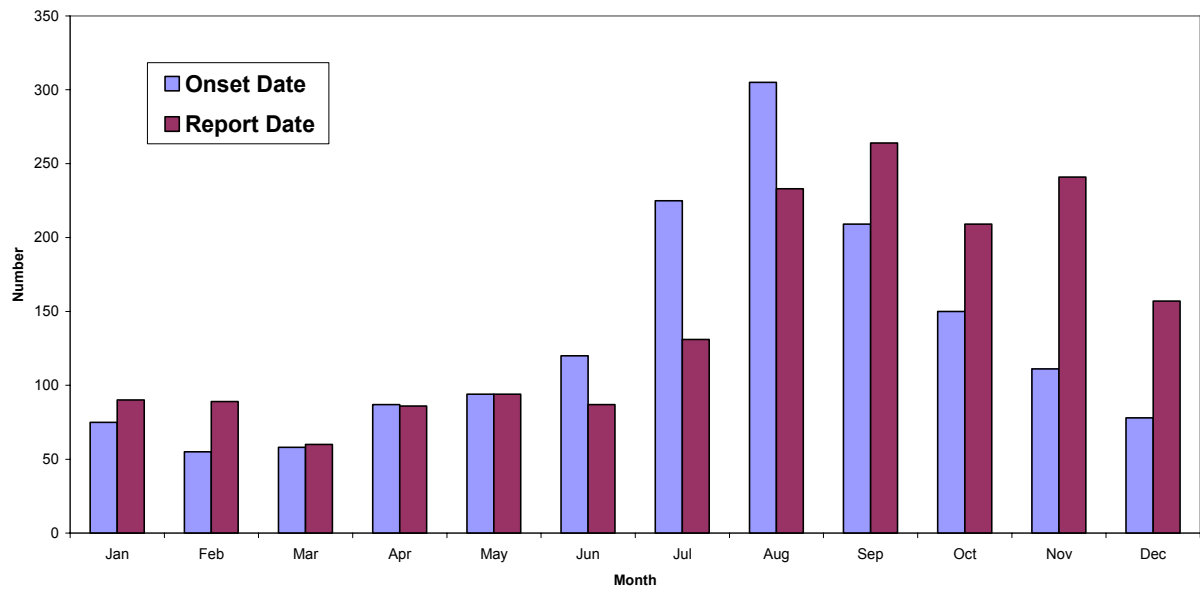
**FIGURE 1. Number of reported pertussis cases, by year, --- Utah, 1906-2005**



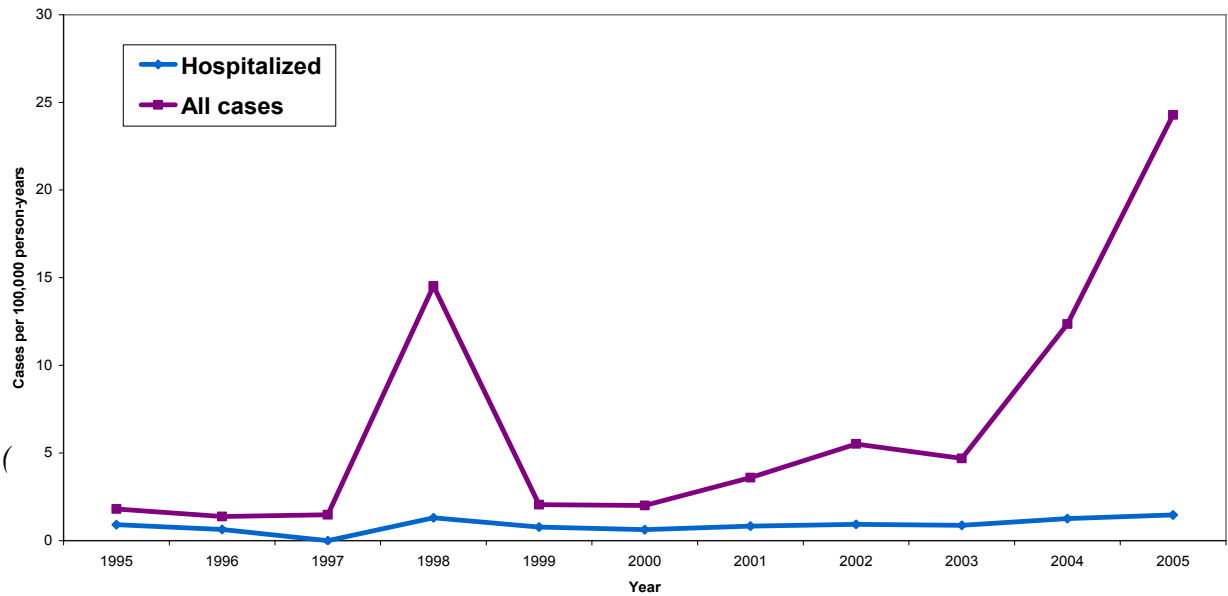
**FIGURE 2. Number of reported pertussis cases, by year and age group, --- Utah, 1995-2005**



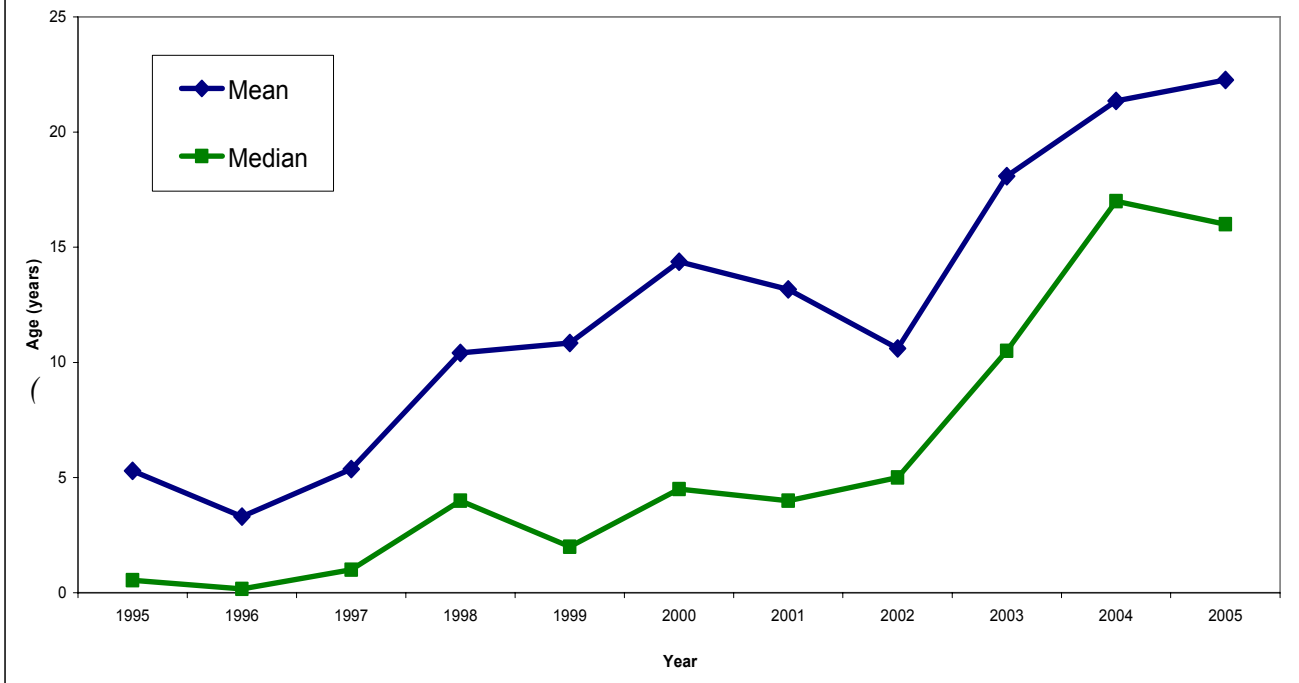
**FIGURE 3. Number of reported pertussis cases, by month of report and disease onset, --- Utah, 1995-2005**



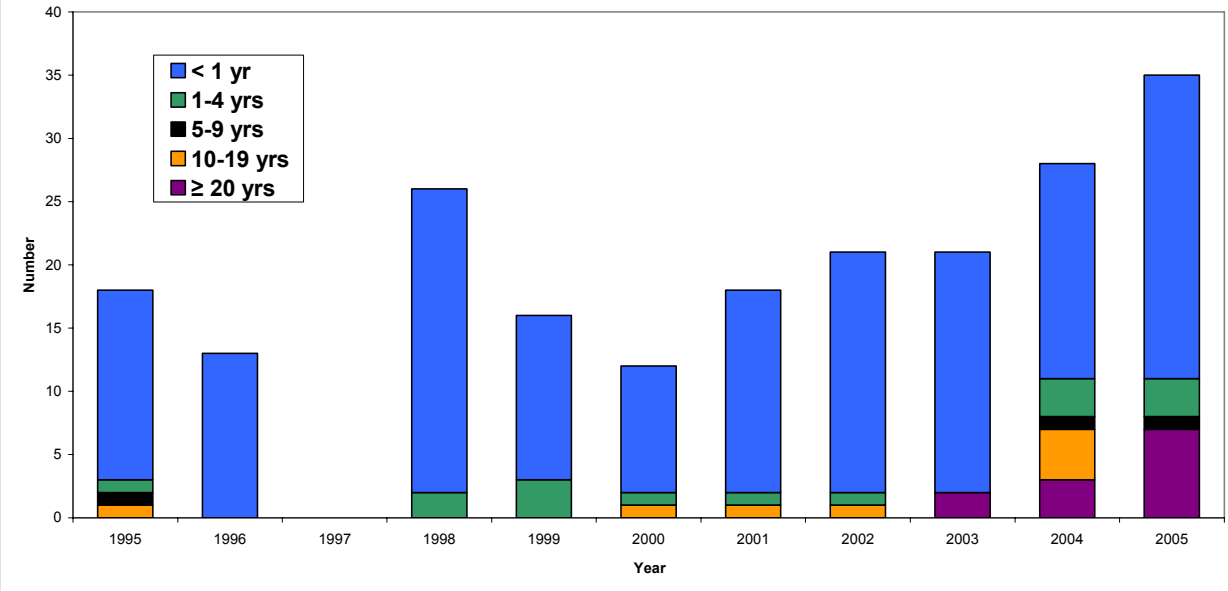
**FIGURE 4. Rate of reported pertussis cases, by year and hospitalization status, --- Utah, 1995-2005**



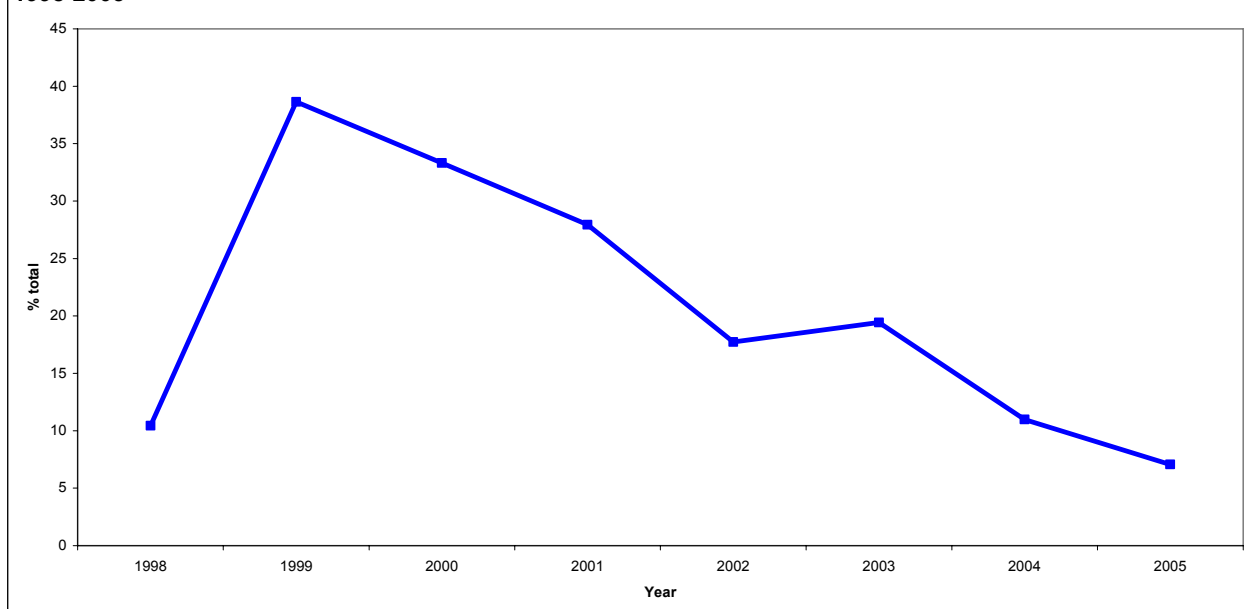
**FIGURE 5. Mean and median age of reported pertussis cases, by year of disease onset, --- Utah, 1995-2005**



**FIGURE 6. Number of reported hospitalized pertussis cases, by year and age group, --- Utah, 1995-2005**



**FIGURE 7. Percent of total reported pertussis cases identified as hospitalized , by year, --- Utah, 1998-2005**



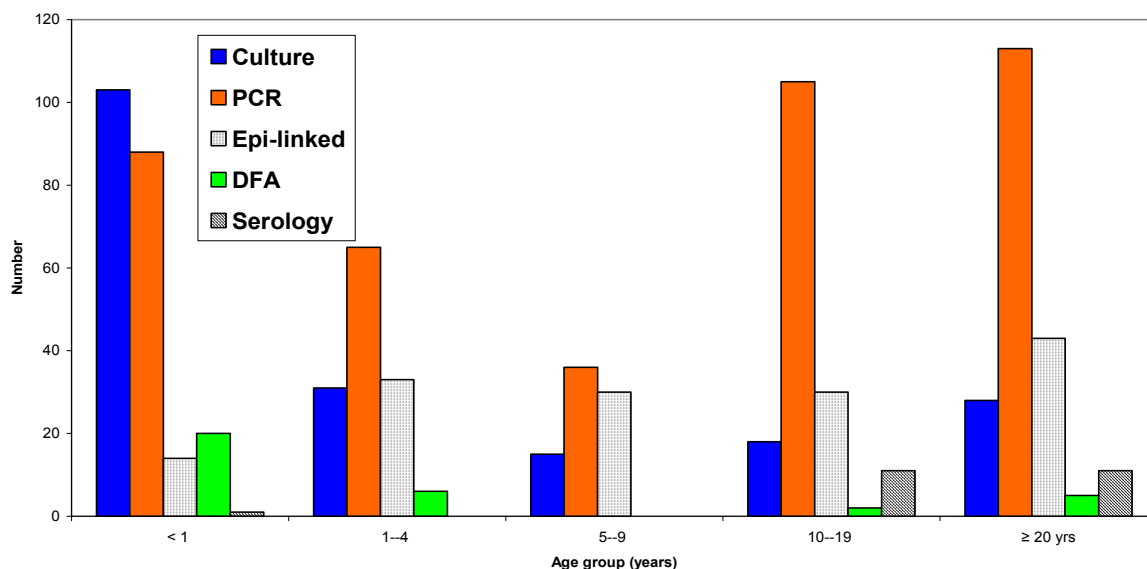
**Table 1: Clinical complications of reported pertussis cases, by age group--- Utah 1995-2005**

Age group	<i>Pneumonia</i>		<i>Seizures</i>		<i>Encephalitis</i>		<i>Hospitalized</i>	
	#	%	#	%	#	%	#	%
< 6 months	32	20.0	5	2.3	1	0.5	166	67.2
6 - 11 months	3	21.4	2	4.4	0	0.0	12	24.0
1 - 4 years	4	6.8	4	1.8	1	0.4	15	6.0
5 - 9 years	2	6.5	0	0.0	0	0.0	3	1.9
10 - 19 years	12	10.2	3	1.0	1	0.3	8	2.4
≥ 20 years	32	13.7	2	0.4	0	0.0	16	3.3
<b>Total</b>	<b>85</b>	<b>13.8</b>	<b>16</b>	<b>1.1</b>	<b>3</b>	<b>0.2</b>	<b>220</b>	<b>14.5</b>

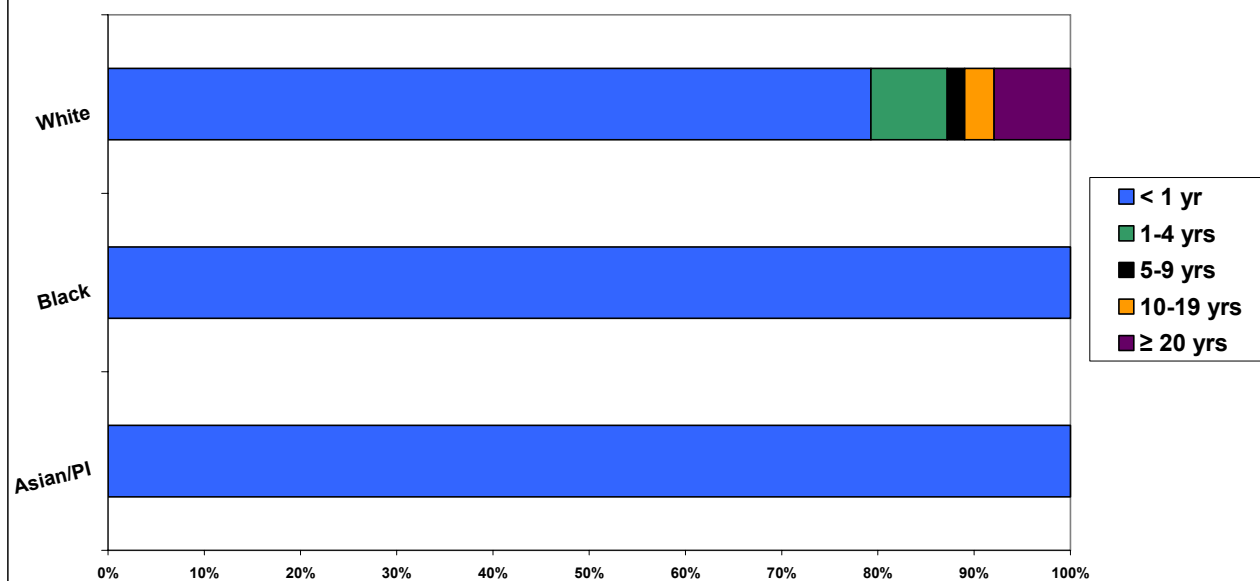
**Table 2: Clinical presentation characteristics of reported pertussis cases, by age group---Utah, 1995-2005**

Age group	<i>Whoop</i>		<i>Vomiting</i>		<i>Paroxysms</i>	
	#	%	#	%	#	%
< 6 months	153	68.0	172	73.2	220	94.4
6 - 11 months	34	69.4	35	71.4	45	91.8
1 - 4 years	123	53.0	152	62.8	212	89.5
5 - 9 years	71	49.3	78	51.3	136	87.7
10 - 19 years	137	48.2	186	60.8	275	91.4
≥ 20 years	241	54.4	220	46.9	434	92.9
<b>Total</b>	<b>759</b>	<b>55.1</b>	<b>843</b>	<b>58.0</b>	<b>1322</b>	<b>91.7</b>

**FIGURE 8. Number of pertussis cases reported as confirmed, by diagnostic method and age group--- Utah, 1995-2005**



**FIGURE 9. Percentage distribution of reported hospitalized pertussis cases, by race and age group --- Utah, 1995-2005**



**FIGURE 10. Percentage distribution of reported hospitalized pertussis cases, by ethnicity and age group --- Utah, 1995-2005**

